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ABSTRACT

This guidebook for teachers is accompanied by a student workbook. The investigations are intended to offer the students an opportunity to learn to use topographic maps and profiles to locate evidence of ancient water levels of Lake Erie and man's use of the beach ridges near the lake. Maps, diagrams, and data tables accompany the written material. (Author/SA)

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OEAGLS- Oceanic Education Activities for Great Lakes Schools

ANCIENT SHORES OF LAKE ERIE

by

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and
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Ohio Sea Grant Program
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SE 028 770

OEAGLS INVESTIGATION 3

Completed April, 1979

This instructional activity was prepared with the support of National Oceanic and Atmospheric Administration Grant Nos. 04-158-44099 and 04-8-M01-170. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the authors, and do not necessarily reflect the views of NOAA.

INVESTIGATION — ANCIENT SHORES OF LAKE ERIE

INTRODUCTION

Have you ever seen Lake Erie? Have you seen pictures of it? Maps? Does it change? You may have seen or heard of waves on the lake destroying houses along the shore. These are certainly changes that can be seen. But does the lake change in size? Was it once bigger than it is today? Or has it moved? Although the lake may seem to be a permanent feature, it is not. All lakes are temporary. They exist for a few thousand years and then disappear. Will this happen to Lake Erie?

Ohio was once covered by ice. These glaciers helped to carve the basin of Lake Erie. About 15,000 years ago the last ice melted back to expose the lake basin. There have been minor advances and retreats of glaciers since then causing the level of the water in the lake to rise and fall. How do scientists determine these past lake levels?

OBJECTIVES

When you have completed this investigation you will be able to:

1. Describe the evidence of past water levels of Lake Erie.
2. Use topographic maps and topographic profiles to locate evidence of past water levels.
3. Describe how man has made use of the beach ridges associated with Lake Erie.
4. Describe some evidence of past changes in the water level of the oceans.

ACTIVITY A — WHAT EVIDENCE IS THERE THAT THE LEVEL OF LAKE ERIE HAS CHANGED?

MATERIALS

Topographic map of the Madison, Ohio, area; road map of Ohio; graph paper and metric ruler.

PROCEDURE

Most lakes are contained in basins with flat, gently sloping floors. Wind causes waves, which in turn produce currents that act along the shores of lakes. These currents carry and deposit sand and form beaches. Perhaps you have swum from a beach. If so, you know what the sand looks like and how it feels.

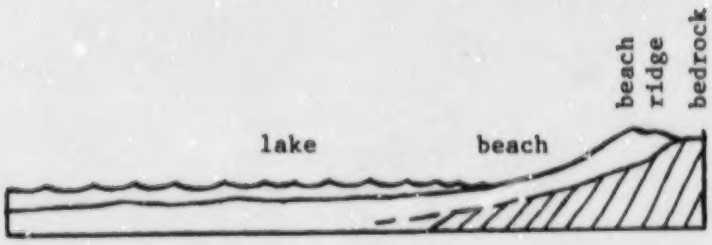


Figure 1. Cross section of a beach.

Figure 1 is a cross section (a side view) of a beach. Notice the flat floor of the lake, the gently sloping beach area itself, and a ridge at the top of the beach. This beach ridge is formed of sand thrown up by the action of waves.

1. What is the contour interval of the map of the Madison area?

   _____

2. Examine the lower left portion of the topographic map. Compare the area immediately north of (above) the Penn Central Railroad with the area south (below) to the map's lower edge. How does the spacing of the contour lines in these areas differ?

   _____

   _____

   What does the difference in the spacing of contour lines mean about the difference in topography in the two areas?

   _____

   _____

3. What evidence is there on the map that the lake once extended through the area north of the Penn Central Railroad?

   _____

4. Construct a topographic profile across North Ridge, Middle Ridge and South Ridge. Start the northern end of your profile where Red Bird Road T-intersects with Chapel Road. The southern end should then be where South Bates Road intersects Interstate 90. What difference between the three ridges does the profile reveal?

_____

_____

5. What do you think caused each of the three ridges?

_____

_____

6. One of the ridges is not as prominent as the other two. What could be the reason for this difference?

_____

_____

7. Determine an "average" elevation for each of the three ridges.

North _____

Middle _____

South _____

8. Compare the elevations of the three ridges to the data in Figure 2. What stage does each of the ridges represent? Label them on the profile.

Years Before Present	Lake Stage	Elevation of Beach Ridge
0	Erie	573
	Lundy (3 ridges)	620-640
10,000	Warren	665-680
	Wayne	660
12,000	Whittlesey	725-735
13,000	Arkona	690-710
	Maumee III	770-780
14,000	Maumee II (2 ridges)	745-755

Figure 2. Data on Beach Ridges

A stage of the lake was a time when the lake level remained the same long enough to build a beach and a beach ridge.

9. How many stages has Lake Erie had? Refer to Figure 2.

_____

10. How old is the oldest stage?_____

11. What evidence do geologists use to tell what stage a ridge belongs to?

_____

12. What do you think could have caused these different stages of Lake Erie?

_____

_____

Glacial ice caused the variation in the levels of Lake Erie. As the glaciers retreated they uncovered different outlets for the lake. These outlets were at successively lower elevations. When a new one was uncovered the lake dropped fairly suddenly to a new level. Occasionally a glacier may have readvanced over an outlet, blocking it. In this case, lake level rose once again, and the beach ridge was eroded by the higher lake. This may be the reason that Middle Ridge is so much lower than North and South Ridge.

ACTIVITY B HOW HAS MAN USED BEACH RIDGES?

MATERIALS Topographic map of Madison, road map of Ohio, and map from The Beach Ridges of Northern Ohio.

PROCEDURE The beach ridges have been very useful to the inhabitants of northern Ohio. What are some of these uses?

1. Examine the three beach ridges on the Madison map. What man-made feature do they have in common?

_____

Why do you think the beach ridges have been used for this purpose?

_____

_____

2. What type of man-made feature is located just southeast of North Perry and north of US Highway 20?

   _____

   How many similar features do you find on Middle Ridge?

   _____ On South Ridge? _____ What use of

   the ridges is implied by these features?_____

   _____

3. What type of man-made feature is located at 41°47'30"N 81°02'30"W (just west of the pond)?

   _____

   How many other features of this type can you find on the

   three ridges?____How many do you find that are NOT located

   on one of the three ridges?_____ Why do people prefer to

   locate these features on beach ridges? _____

   _____

4. Ask your teacher for a different map. How many beach ridges can you identify on this new map?_____

   What stages do they represent?_____
   Which of the man-made features you identified in Steps 1 to 3 are found on the ridges on this map?

   _____

   _____

These beach ridges extend throughout northern Ohio. They indicate the location of the shoreline of the lake and the amount of area occupied by the lake at each of its stages. Your teacher will have a map of northern Ohio posted on the bulletin board. This map locates each of the beach ridges.

5. In an earlier part of this activity you learned that the people living in this area built many of their roads along the beach ridges. Using your road map and the map on the

bulletin board, identify the major highways that have been built on beach ridges. Mark each of them on your road map. Label them with the name of the stage of the beach ridge.

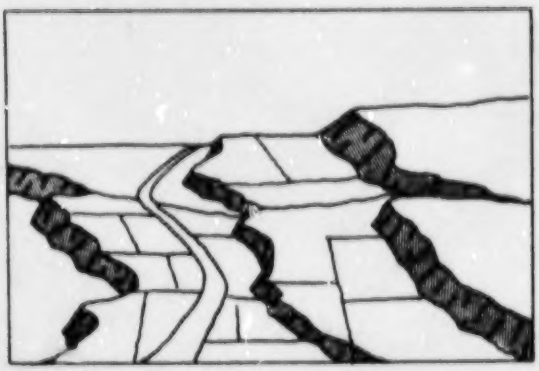
6. List below all of the uses people have made of beach ridges in the areas you have studied.

_____

_____

You have learned in this Investigation that the movement of glaciers caused changes in the level of Lake Erie and that the beach ridges provide evidence of such changes in lake level. The oceans have also had different levels of water. Figure 3 illustrates some of the evidence of higher sea level (marine terraces) and lower sea level (wave-cut cliff).

Marine Terraces



Wave-cut Cliff

Figure 3. Evidence of sea level changes.

Glaciation is also one of the causes of recent variations in sea level. As the glaciers have melted, the water returned to the sea, raising its level. There are other causes of sea level change that your teacher may wish to discuss.

REVIEW QUESTIONS

1. What evidence is there that indicates that Lake Erie has been larger than it is today? _____

   How do these features form? _____

   _____

2. Discuss three ways that man has used beach ridges.

   _____

   _____

   _____

3. What caused the level of water in Lake Erie to change?

   _____

   _____

4. Many types of fruit require well-drained soil. Why would beach ridges be good places for orchards?

   _____

   _____

ohio sea grant

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TEACHER GUIDE

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Appendix D is from the publication by Jane Forsyth entitled The Beach Ridges of Northern Ohio. Ohio Geological Survey Information Circular #25. Columbus, Ohio, 1959.

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OVERVIEW

In this investigation students work with topographic maps and profiles to identify beach ridges in northern Ohio. They learn how to determine the ages of the ridges, how they were caused and how people in the area have utilized them.

PREREQUISITE STUDENT BACKGROUND

Students should be able to read a topographic map and construct a profile. They should also be somewhat familiar with the glacial history of the Great Lakes Region.

OBJECTIVES

When the students have completed this investigation they will be able to:

1. Describe the evidence of past water levels of Lake Erie.
2. Use topographic maps and topographic profiles to locate evidence of past water levels.
3. Describe how man has made use of the beach ridges associated with Lake Erie.
4. Describe some evidence of past changes in the water level of the oceans.

MATERIALS

The following are needed for each group:

1. Copy of the Madison quadrangle.
2. Graph paper and metric ruler, pencil.

One copy of each of the following should be posted in the classroom:

1. An Ohio road map.
2. Copy of the map from the publication: The Beach Ridges of Northern Ohio (included in this teacher guide.)

Also, several copies of each of the following quadrangles; Geneva, Perry, Mentor and Eastlake. These are available from the Ohio Division of Geological Survey, Fountain Square, Columbus, Ohio. In 1978 they cost $1.25.

SUGGESTED APPROACH

The investigation can be done individually by students, or in groups of two.

ACTIVITY A

WHAT EVIDENCE IS THERE THAT THE LEVEL OF LAKE ERIE HAS CHANGED?

The questions are designed to lead the students to closely examine an area near Lake Erie to identify evidence of former Lake levels.

PROCEDURE AND QUESTIONS

1. 10 ft. contour interval.

2. North of (above) the Penn Central Railroad, the contour lines are farther apart than south of (below) the Penn Central Railroad. Where contour lines are closer together the area has more relief, or is "hillier." Where contour lines are farther apart, the slopes are gentle or nearly flat. Therefore, there is a change in topography in this area.

3. The area north of the Penn Central Railroad is flat similar to the lake bottom in Figure 1. In addition, there are areas of swamps. There is evidence that the lake may once have extended over this area.

4. Be certain students use graph paper for the profile, and that they accurately record each contour line. If the profile is not done very carefully, the ridges may not be apparent on the profile.

A completed profile is included as Appendix A. It has a vertical exaggeration of 40:1. This scale makes identification of the ridges easier, but greatly exaggerates the vertical, making the gently sloping "old lake" floor appear hilly. Here would be an excellent opportunity to discuss vertical exaggeration in more detail. Have your students redraw the profile using a much lower vertical exaggeration of perhaps 10:1.

Vertical exaggeration is determined from the scales to which the profile is drawn. That in Appendix A is drawn to a vertical scale of 1 inch = 50 ft. and a horizontal scale of 1 inch = 2000 ft. The horizontal line would have to be extended 40 times or the vertical line compressed 40 times to make the scales the same. Therefore, we say the vertical exaggeration is 40:1 or 40x. To redraw the profile using a scale of 10:1, your vertical scale would have to be 1 inch = 200 ft. A profile with this scale will be harder for the students to graph but will give a more realistic look at the slope of the land.

A profile with vertical exaggeration of 10x is included as Appendix B.

5. Each one of these ridges is a beach ridge. They mark the previous beaches or boundaries of Lake Erie. They are built up by wave action as described below Figure 1 of the Student Guide.

6. Middle Ridge is not as prominent as the North or South Ridge. The lake's edge may not have been there long enough to build up a higher beach ridge. Middle Ridge may have been smoothed out by flooding during an increase in lake level.

7. North Ridge 675 ft.
   Middle Ridge 695 ft.
   South Ridge 725 ft.

8. North Ridge = Lake Warren
   Middle Ridge = Arkona
   South Ridge = Lake Wittlesey

9. 8 stages

10. 14,000 years before present.

11. Its elevation.

12. Here the answers may vary because we are asking the students to "think." The actual cause was the retreat and readvance of glacial ice opening up new lake drainage points and closing older ones (as described in "Background Information".)

ACTIVITY B HOW HAS MAN USED BEACH RIDGES?

INTRODUCTION

This activity leads the students to discover how man has made use of beach ridges. Evidences of changes in sea level are also discussed.

PROCEDURE AND QUESTIONS

1. North and South Ridges have a highway along their entire length. Middle Ridge also has a highway along most of its length.

   The beach ridges were used as highways for a variety of reasons. The bedrock surface on each side of the ridges is covered by glacial till. These areas are generally swampy due to low relief and poor drainage. Therefore, the buffalo in Ohio's early history chose the drier, better drained beach ridges for their trails. The Indians, hunting the buffalo, naturally followed the same trails. When the settlers moved into and across the State, they also followed these "established routes," as did the modern highway builders.

2. A gravel pit, as indicated by . Two sandpits and a quarry along Middle Ridge. One gravel pit on South Ridge. Man is quarrying the sand and gravel from the beach ridges for use in concrete for construction.

3. Middle Ridge cemetery is located here. There is one cemetery on each of the North and South ridges and two cemeteries on Middle Ridge. There are only two cemeteries on this quadrangle which are not located on the ridges; one of these is on the glacial till forming the lake floor. The other one is in the hills to the south. People tend to locate cemeteries in high areas where drainage is good and flooding is minimal.

4. Answers here will vary, depending upon which quadrangle the students use. Quadrangles to use are: Geneva, Perry, Mentor, and Eastlake.

5. A copy of the northern-most sections of Ohio's road map is included in Appendix C. The beach ridges are marked. Appendix D is entitled "The Beach Ridges of the Glacial Lakes," mapped by Frank J. Carney and generalized by Jane L. Forsyth. The map is reproduced from Ohio Geological Survey's circular no. 25, The Beach Ridges of Northern Ohio by Jane L. Forsyth.

6. Answers will vary but should include roads, cemeteries, and construction material.

Glaciation has also been one of the agents responsible for recent changes in sea level. Water locked up in the glacial ice has come from precipitation collected over the oceans. The removal of this water lowered sea level greatly. If the present-day glaciers should melt, sea level would probably rise from 40 to 50 meters.

When sea level is lowered, the size of the continental shelf decreases, thereby decreasing the habitat of shelf-living organisms. Shorelines become broad, relatively flat areas. Land plants and animals can extend their ranges outwards. The climate of local areas may be affected by the change in its proximity to a large body of water.

Current evidence seems to show that Antarctica has been getting warmer over the last 100 years or so. This could eventually trigger a great deal of melting of glacial ice and the consequent increase in sea level worldwide.

Marine terraces are evidences of a higher sea level because they are formed by wave action. An example would be Palos Verdes Hills, California (photograph pg. 209; Investigating the Earth, 3rd Edition, 1978).

Perhaps you could discuss other evidences of sea level changes such as: fossil ripple marks, seamounts, and fossilized sea life found in sedimentary rocks on land.

REVIEW QUESTIONS

1. A large, relatively flat area with several swamps and poor drainage. Ridges of sand and gravel (beach material) roughly paralleling the present shoreline.

2. Man has used beach ridges for highways, for cemeteries and as sources of sand and gravel.

3. The level of water in Lake Erie fluctuated as the lake's outlet was changed by the retreat and readvances of glacial ice.

4. The beach ridges and the immediate areas are composed largely of gravel covered with soil. The area is better drained and therefore provides an excellent location for orchards.

BACKGROUND INFORMATION

Beach ridges are formed by storm waves, similar to the berms along the ocean beaches. An excellent source of background reading concerning their formation is Waves and Beaches by Willard Bascom, Chapter IX, Beaches. Each ridge represents an ancient beach formed along the shore of Lake Erie at a time in the past when the elevation of the lake was much higher than it is today. These higher lake levels were caused by the glacier damming the lake's outlet. As the ice front retreated, a series of newer and lower outlets were exposed, so the lake level lowered, changing the outlines of the lake and thus the beach patterns. Several times the ice readvanced, causing the lake level to rise and submerge the beach ridges made during a previous stage. The higher water would then scatter the materials making up the beach ridges and smooth them.

REFERENCES

Forsyth, Jane, 1959. The Beach Ridges of Northern Ohio. Ohio Geological Survey Information Circular No. 25, Columbus, Ohio, illus. 10 pp.

Bascom, Willard, 1964. Waves and Beaches. Doubleday and Co.

Earth Science Curriculum Project, American Geological Institute, 1978, Investigating the Earth, Houghton-Mifflin, illus. 557 pp.

EVALUATION ITEMS

1. What causes the formation of beach ridges?

   1. localized flooding
   *2. waves
   3. glaciers
   4. low water level

2. What is one type of evidence used by scientists to locate a former shoreline of a lake?

   1. hilly terrain
   *2. beach ridges
   3. gravel pits
   4. cemeteries
   5. highways

3. Two separate beach ridges occur close to each other near Lake Erie. What is the best evidence that they were made during the same lake stage (are the same age)?

   1. They each have a road on top of them.
   2. They both have cemeteries on them.
   3. They have the same amount of sand and gravel in them.
   *4. Their tops are at the same elevation.

4. Which of the following land forms that occur along a seashore is the result of a rise in sea level (sea level was lower in the past)?

   1. marine terraces
   *2. wave-cut beaches
   3. beach ridges
   4. sand bars
   5. spits

5. What is a major use of beach ridges in Northern Ohio?

   *1. highway routes
   2. garbage disposal
   3. ground water sources
   4. boat launching ramps

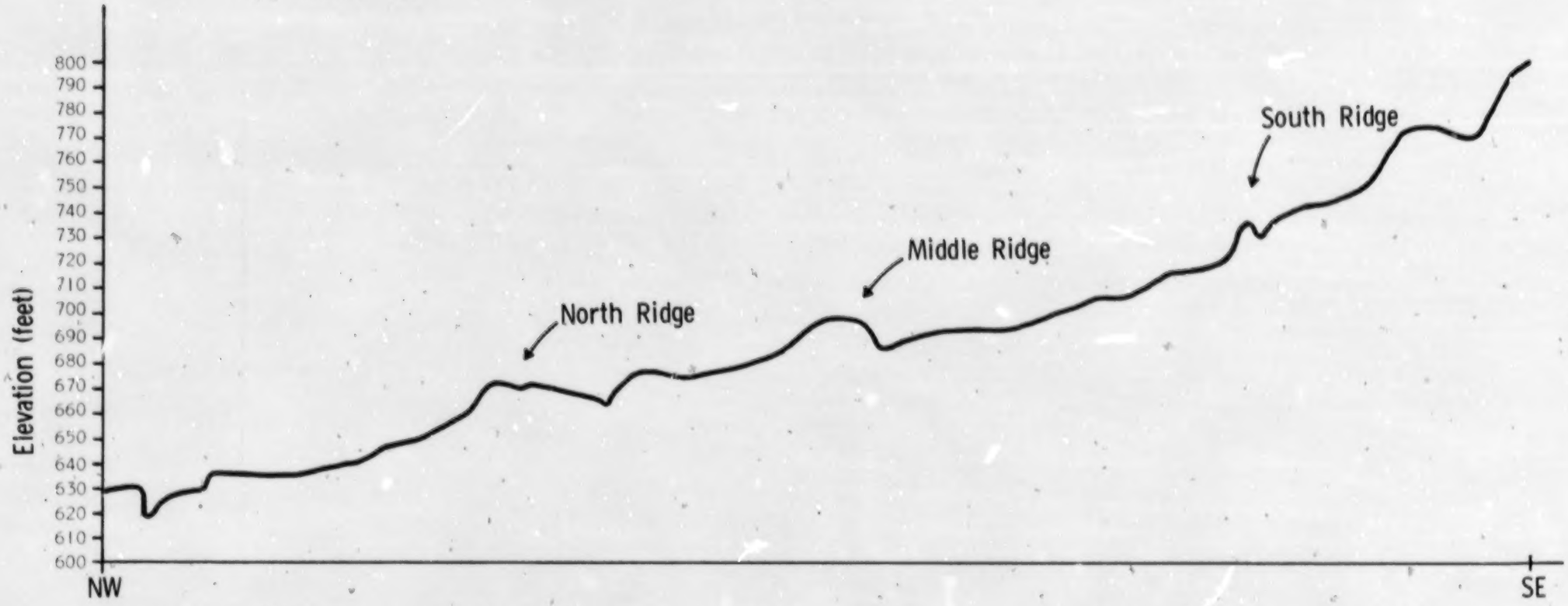
6. There is evidence that there have been large changes in the level of Lake Erie in the past. The probable cause of large changes in lake level is

   1. a sudden change in the course of a river.
   2. annual changes in the amount of precipitation falling into the lake.
   3. the erosion of the Niagara River Gorge at Niagara Falls.
   *4. movement of large continental glaciers.

7. Which of the following construction materials can be obtained from beach ridges?

   1. limestone
   2. sandstone
   *3. sand
   4. lumber
   5. clay

Appendix A.

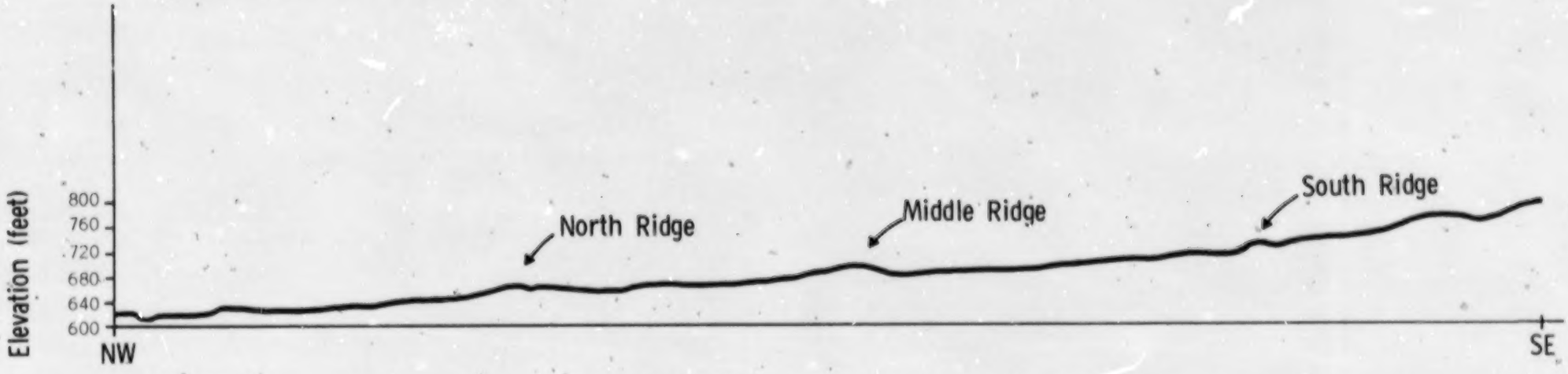


V.E. = 40X

Horizontal Scale = 1 inch equals 2000 feet

Vertical Scale = 1 inch equals 50 feet

Appendix B.



V.E. = 10X

Horizontal Scale = 1 inch equals 2000 feet

Vertical Scale = 1 inch equals 200 feet

APPENDIX C. Road Map of Ohio with beach ridges marked.

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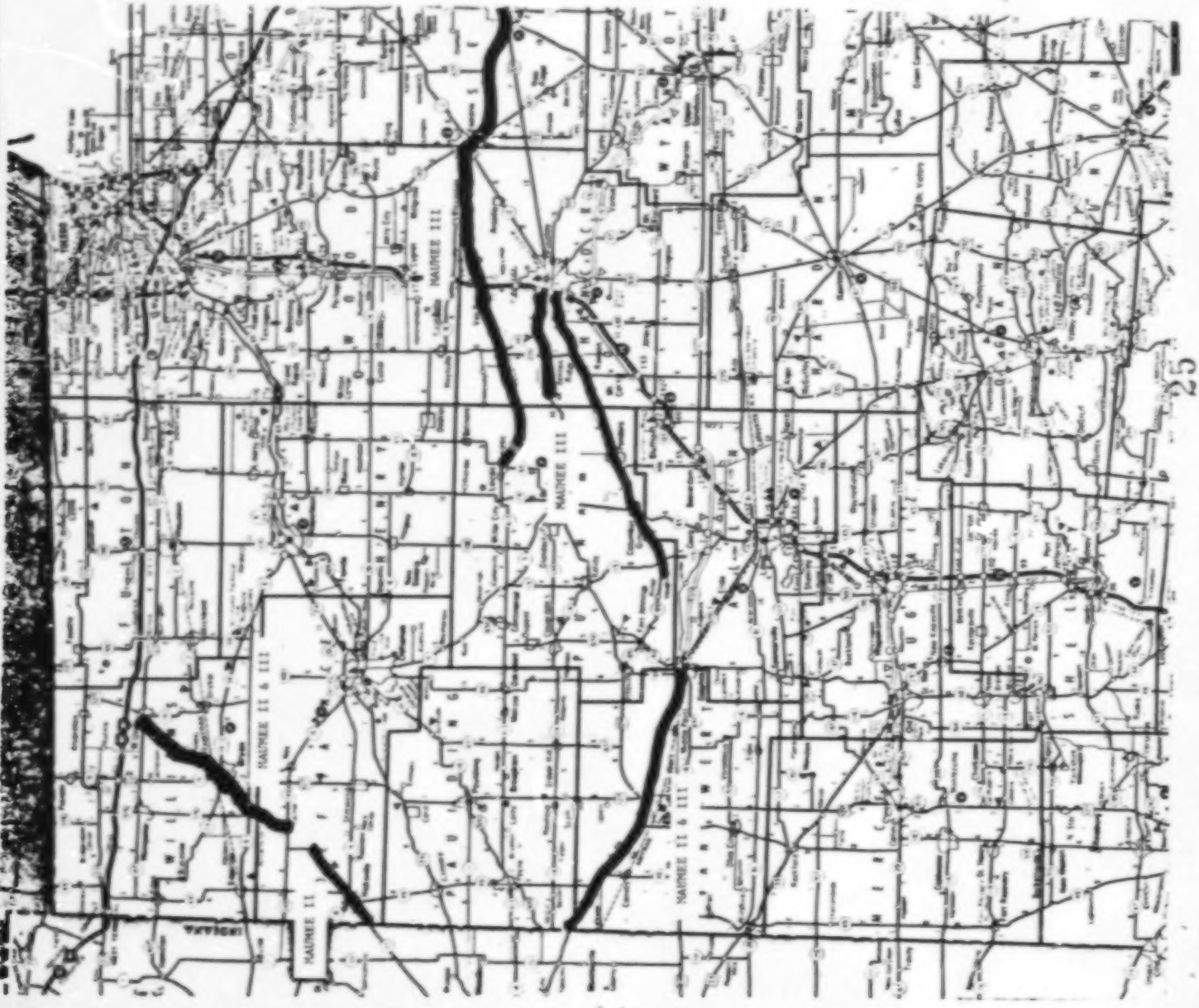
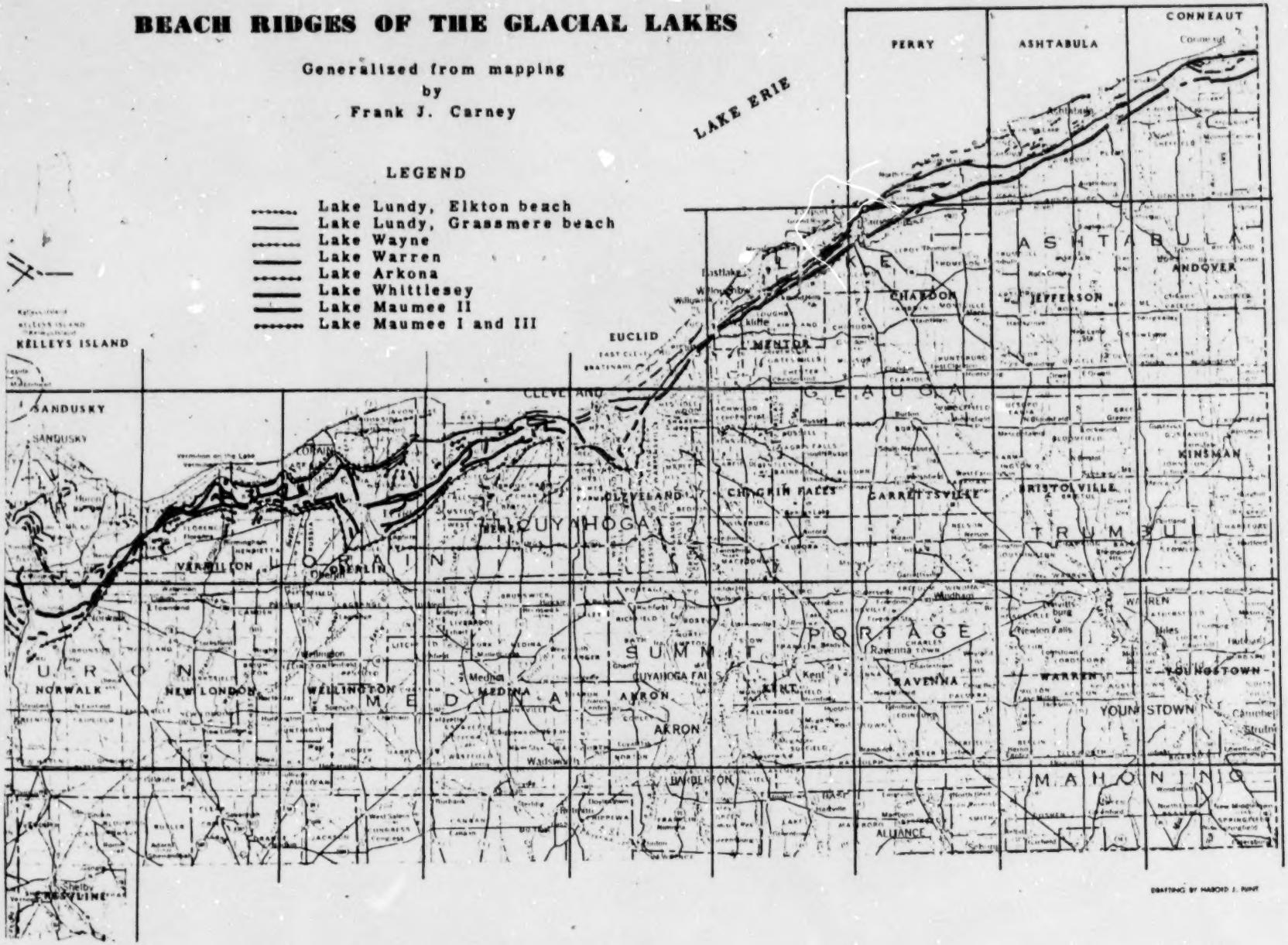
Attach page 9 here



APPENDIX D

BEACH RIDGES OF THE GLACIAL LAKES

Generalized from mapping
by
Frank J. Carney



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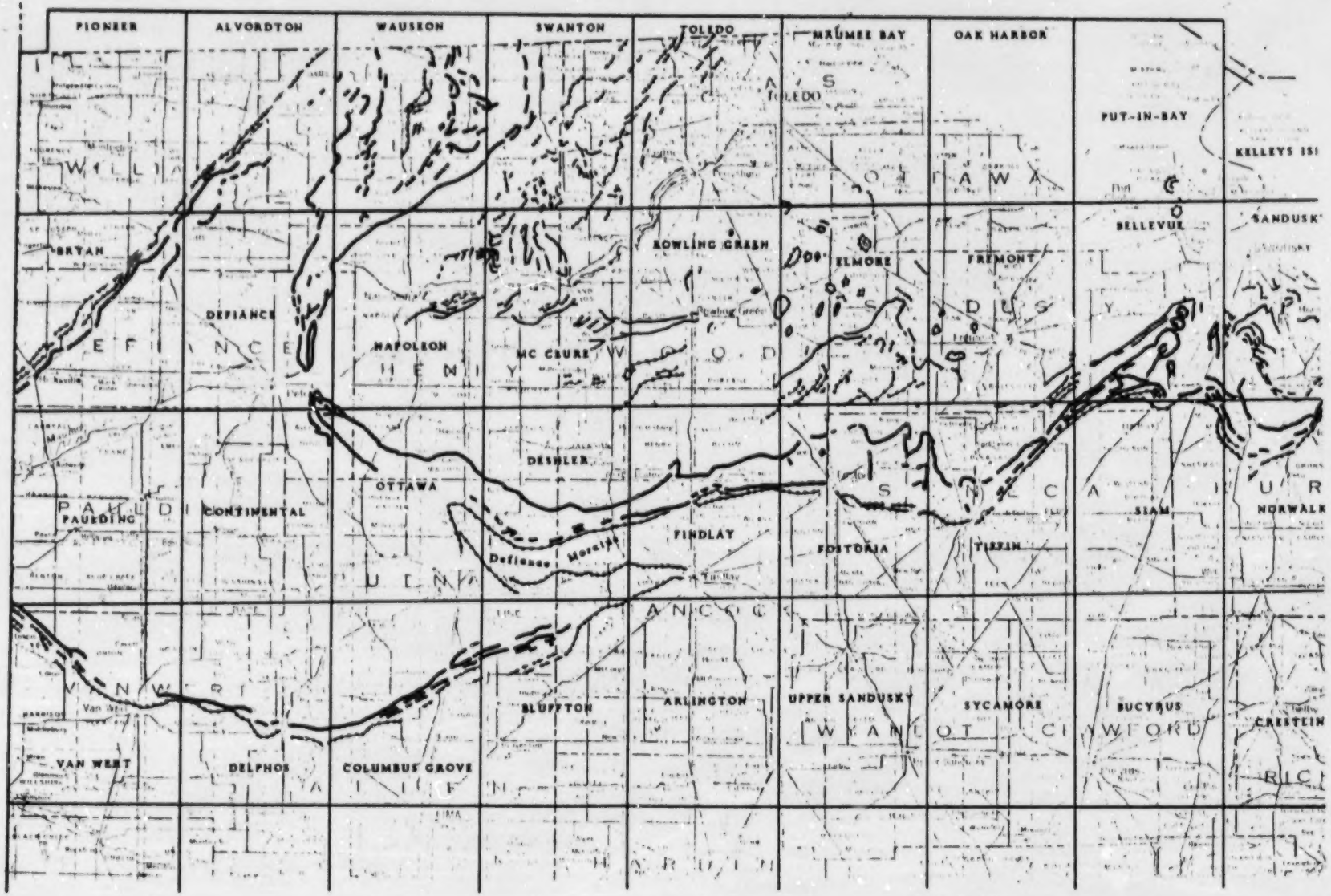

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